

Air Traffic / Technical Operations Human Factors
Strategic Research Plan
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Human Factors Division
Federal Aviation Administration





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Message from the Division Manager

Since its inception 90 years ago, the air traffic control (ATC) industry has changed dramatically. Due to increases in volume and system-wide complexity, methods of controlling traffic, communication, automation, and National Airspace System (NAS) infrastructure have evolved to meet up-to-date safety standards and consumer needs.

Prior to oversight and regulation, the first air traffic controllers communicated with aircraft via visual signals. The concept of controlling traffic eventually matured and controllers began tracking en route flight progress on blackboards and maps with the assistance of boat-shaped weights later called “shrimp-boats”. During the post-World War II era, oversight, safety, and system capacity moved to the forefront of the aviation industry. In the 1960’s, the Federal Aviation Administration (FAA) began modernizing the NAS. Radar, computers, and radio communications equipment were implemented in air traffic facilities. Since then, levels of air traffic and flight deck automation have dramatically increased to assist controllers and pilots in improving safety, situational awareness, human performance, capacity and efficiency.

As levels of automation continue to increase, human-to-human and human-to-system interactions may inherently change. In response to the FAA’s recent execution of Destination 2025, human factors research has become one of the main issues that must be addressed so the FAA can maintain a high level of human performance and safety. In the air traffic and technical operations (TO) domains, new automation, capabilities, decision support tools, procedures, and policies will be implemented. Some will be implemented in parallel with legacy technologies still in place, while others will replace legacy technologies. During this powerful, incremental transition, human systems integration research is needed to provide the FAA with comprehensive human factors solutions with a focus on human centered design and post implementation assessments to further enhance fielded products or procedures.

The mission of the Air Traffic Control / Technical Operations Human Factors Team is to provide human factors research, engineering, and leadership to enhance operational human performance in the NAS. Our findings and products will enable the FAA to achieve its mission to provide the safest, most efficient airspace system in the world.

This plan is our commitment to provide the FAA, its operational workforce, and flying public with the highest quality human factors research products that yield the greatest operational impacts supporting the transition to a NAS of the future.

Paul Krois, Ph.D., PMP

FAA Human Factors Division Manager

Introduction

Strategic Plan

The mission of the Air Traffic Control/Technical Operations (ATC/TO) Human Factors Team is to:

Provide human factors research, engineering, and leadership to enhance operational human performance in the NAS. Our findings and products will enable the FAA to achieve its mission to provide the safest, most efficient airspace system in the world

Human factors is a multidisciplinary field that develops and applies knowledge about the performance of humans in specific domains to influence the system design. Human factors incorporates expertise from psychology, engineering, usability, interface design, anthropometry, and operations research in order to maximize human-system performance. This wide array of specialties directly influences individual and team human performance, human-system safety, user-system design, and selection criteria and processes. The ATC / TO Human Factors Team aims to improve all of the aforementioned areas specifically in the operational Air Traffic (AT) environment through research and collaboration with internal and external FAA AT directorates and stakeholders. This strategic plan defines a clear path for the research program to improve and integrate human factors in ATC.

The success of the team's mission is dependent on the effective execution of the AT / TO Human Factors Strategic Plan. The Plan is composed of sections describing five research categories. Each category consists of human factors objectives and strategies. Objectives are defined as broad, forward-looking goals that the ATC / TO Human Factors Team must address in order to achieve the team's mission. Strategies are defined as specific human factors research areas that must be addressed to achieve the corresponding objective.

Research objectives and strategies were defined by identifying the current state of the NAS, human factors gaps, and opportunities for future research advancement. Inputs from human factors subject matter experts and program stakeholders assisted in the identification of these criteria. Functionally, the plan will be used as a driver for the Annual Human Factors Division Research and Development Plan and prioritization of research requirements identified by internal FAA sponsoring organizations throughout the Technical Community Requirements Group process.

The five research categories are described at a high level below:

- ◆ **Research for Operations:** The “Research for Operations” category is comprised of objectives and strategies that are focused on the integration of human factors personnel at the facility level to improve user engagement, human performance, safety, post solution implementation assessments, as well as consumer change management.
- ◆ **Human Centered Design:** The “Human Centered Design” category is comprised of objectives and strategies that are intended to improve workstation design and displays to improve human system performance.
- ◆ **Human Systems Integration:** The “Human Systems Integration” (HSI) category is comprised of objectives and strategies that focus on the integration and harmonization of the four HSI research domains: Human Factors, Safety, Training, and Personnel Selection. These domains are intended to serve as a coordination tool between developmental concepts, active research requirements, planned research requirements, and FAA programs.
- ◆ **Selection and Training Process Improvement:** The “Selection and Training Process Improvement” category is comprised of objectives and strategies that are intended to proactively identify future FAA workforce selection needs, updating the selection process as identified needs change, and validate FAA selection methods.
- ◆ **Increase Human Performance and Safety:** The “Increase Human Performance and Safety” category is comprised of objectives and strategies that support the consistent integration of Safety Management System updates across the FAA and the proactive identification of human performance risks prior to procedure or design implementation.

Programmatic Purpose

The AT / TO Human Factors Strategic Plan was a self-sponsored effort endorsed by the Research Engineering and Development Advisory Committee (REDAC). This plan also addresses recommendations provided by the United States Government Accountability Office (GAO, 2010) to further coordinate cross agency human factors plans during the transition to an automated future NAS. Execution of this strategic plan will provide the ATC / TO Human Factors Team with a 10-year programmatic direction and focus. It will also assist in the establishment of research partnerships across inter-government agencies, internal FAA and external research laboratories, as well as industry and academia. The strategic plan will also serve as an external communication tool for the ATC / TO Human Factors Team to further engage the human factors community of practice to produce the highest quality human factors products that yield the greatest operational results.

The ATC / TO Human Factors Team currently provides human factors research and engineering services to the Air Traffic Organization (ATO) and other internal directorates throughout the FAA Acquisition Management System (AMS) process and product development lifecycle. The Team also provides research addressing the selection and training of Air Traffic (AT) operations personnel.

The ATC / TO Human Factors Team resides within the Human Factors Division which supports the Advanced Concepts and Technology Development Directorate. The mission of the Advanced Concepts and Technology Development Directorate and its sub-directorates is to “identify, execute, and manage research and development projects related to existing and new technologies and procedures consistent with the FAA’s mission” (FAA, 2012a).

As the FAA moves towards the achievement and sustainment of a future automated NAS, the ATC / TO Human Factors Team will continue to support the FAA Administrator’s goals outlined in Destination 2025 by executing the following internal programmatic performance areas:

- ◆ Lead and facilitate the coordination of cross-domain and cross-program human factors expertise to support the FAA mission
- ◆ Conduct applied human factors research in the AT and TO domains
- ◆ Reduce the probability of human error when operational personnel provide AT and maintenance services to the National Airspace System (NAS)
- ◆ Provide the human factors community of practice with tools that enable them to add value to the FAA AMS process and the product development lifecycle
- ◆ Foster an atmosphere of “research to practice” ensuring that research products are implemented and support the Advanced Concepts and Technology Development Directorate mission
- ◆ Increase project, programmatic, and Agency success through the development and implementation of a FAA change management process

Research conducted by the ATC / TO Human Factors Team is driven by Destination 2025, the Advanced Concepts and Technology Development Directorate mission, operational needs by internal FAA sponsoring organizations, and the National Aviation Research Plan (NARP).

Human Factors Across the Lifecycle

The ATC / TO Human Factors Team provides research, engineering services, and products throughout the FAA AMS process to the AT and TO Organizations. The products add value to the product development lifecycle in order to achieve the desired level of human performance and operational safety during solution implementation and in-service management.

It is a priority for the Team to remain engaged with FAA programs throughout the entire AMS process, shown below in Figure 1.

Based on lessons learned, integrating and embedding human factors in system and equipment acquisitions decreases product lifecycle costs, improves human-system performance, and significantly reduces risk. If human factors is not an integral part of acquisitions, operational needs may not be met, schedule delays may be incurred, and programmatic costs may significantly increase due to reactive re-engineering efforts.

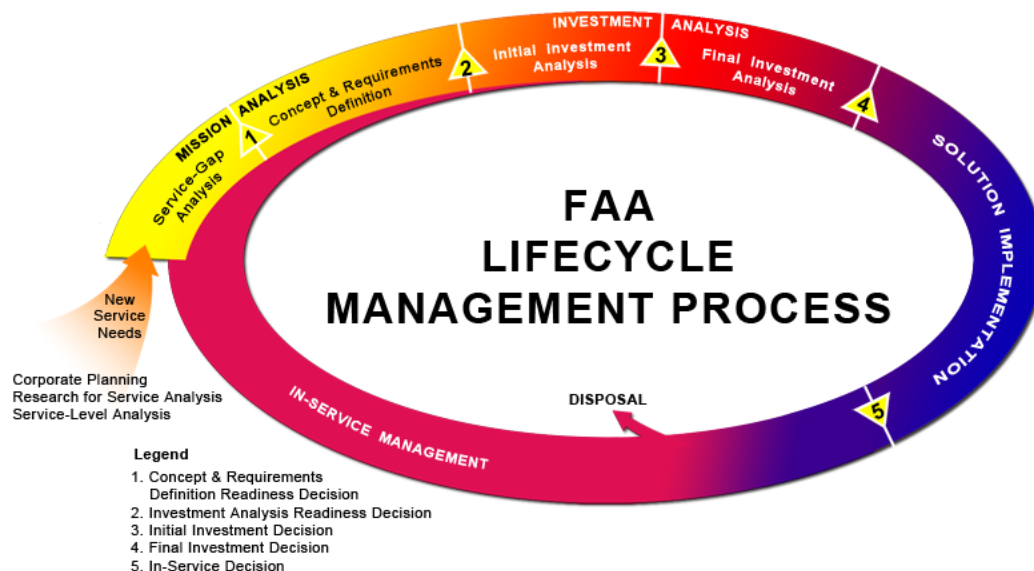


Figure 1: FAA Lifecycle Management Process (FAA, 2012c)

At face value the AMS process appears to only be applicable to FAA system acquisitions. From a human factors perspective, the AMS decision points are also applicable to the FAA workforce if the decision point drivers are redirected towards personnel selection and training concepts.

From a selection standpoint, the Team is responsible for responding to the “New Service Needs” of the AT and TO Organizations. For example, during the transition to an automated NAS, the Team will identify changes in the roles and responsibilities of Air Traffic Control Specialists (ATCS) and TO personnel (AMS Decision point 1, service gap analysis). This leads to identification of required knowledge, skills, abilities and other characteristics (KSAO) for the future workforce selection. Once KSAOs are defined, updated selection tests and processes are required (AMS Decision point 1, concept requirements definition). When an operational vacancy exists, the FAA recruits potential candidates that possess the required abilities and other characteristics. Applicants meeting these criteria participate in the FAA selection process (AMS Decision point 2, initial investment analysis). Selected candidates then go through the required FAA training to acquire knowledge and skills for on-the-job certification and are required to complete a final performance verification (AMS Decision point 3, final investment analysis). Upon completion, the employee then transitions to a facility where they engage in facility-specific training (AMS Decision point 4, solution implementation). When facility-specific requirements are met, the FAA provides recurrent training and interim evaluations so the employee maintains currency and proficiency (AMS Decision point 5, in-service management). Finally for ATCS, at the age of 56, they retire from the system completing the process (AMS “disposal”).

Understanding human-system performance from a design and operational concept is vital to procuring systems that meet operational needs. Also having the right people with the right skills to operate those systems is equally important to safely meet NAS consumer needs. Products developed by the ATC / TO Human Factors Team promote application of the human centered design concept and harmonization of the human systems integration domains. This provides the FAA with end-to-end system and human factors research and engineering support to apply comprehensive solutions to the AT and TO domains.



Research for Operations

Strategic Objective 1

Provide In-Service / Post Implementation support to the Air Traffic and Technical Operations Organizations to enhance fielded systems, procedures, and operations

“One of the most complex challenges today is meeting the expectations for all system users for their operational needs, increasing capacity, efficiency, and predictability, while enhancing safety, mitigating environmental impacts, and operating in a seamless global environment” (FAA, 2012b). Significant updates within AT and TO will be required to address these forward-looking challenges. Therefore, the primary goal of the ATC / TO Human Factors Team is to conduct research for operations that positively impact the AT and TO Organization’s systems, human performance during daily operations, safety, human factors policy inputs, and decision making.

Updates to the AT system will introduce an element of change when implemented. Consuming change whether it is on a human or system level can be challenging if the product is not well received. End-users must be presented with clear criteria or objectives for change, involved in the change process where possible, presented change in a non-threatening environment, and most importantly given the ability to provide feedback.

To increase safety, usability, and success of future NAS products, the Team will engage in change management research. The Team will also improve the engagement of operations so post product implementation feedback can be solicited and utilized to further improve the human component of the NAS.

Strategy 1.1

Develop a Change Management strategy for the Air Traffic Organization to transition from current operations to an automated future NAS

Change Management is a structured process that manages the transition of individuals, teams, and organizations from a current state to a desired future state. This formal process is executed independently but in parallel with technical project management activities to ensure successful

project completion and product implementation with maximized user-acceptance and reduced safety risk(s).

“The FAA’s mission is to provide the safest, most efficient aviation system in the world” (FAA, 2012b). In order to achieve this “inter-linked programs, systems, and policies” are in development to “dramatically change the way the current aviation system operates” (FAA, 2012b). These changes will result in technical, cultural, environmental, and responsibility changes of ATCS and TO personnel. To ensure successful, safe implementation of these changes, a formal FAA change management process needs to be developed for the ATO.

The ATC / TO Human Factors Team is addressing change management from a programmatic vantage point in several research areas. They include updates to personnel selection processes, infusing the HSI concept into system design and operations, and improvement of human performance and safety so the probability of human error is decreased as levels of AT system automation increase. From an operational standpoint, there are still several opportunities for human factors change management research. Preliminary activities include:

- ◆ Development of a human factors process to engage program stakeholders to identify procedural, operational, and potential environmental impacts affecting operations through the implementation of a proposed change
- ◆ Development of training requirements and processes to be administered to ATC / TO managers and supervisors to ensure operational personnel positively adapt workplace changes
- ◆ Development of a process for human factors personnel to conduct post-implementation assessments of fielded systems, capabilities, procedures, and policies at the facility level to improve user engagement and operations

Change management products for operations will:

- ◆ Improve organizational safety culture and awareness
- ◆ Improve safety event data collection
- ◆ Promote communication between the facilities and upper level management
- ◆ Establish a positive alignment of facility and upper-management expectations
- ◆ Increase user automation and procedural change acceptance



Strategy 1.2

Integrate human factors into day-to-day AT operations to improve human performance and safety in the NAS

The majority of “In-Service Management” activities assess AT and TO system performance against legacy system performance. Ensuring that newly implemented systems meet their predetermined success criteria is vital to transitioning to an automated NAS. Ensuring that NAS service providers and maintainers are safely, effectively, efficiently, and willingly using these newly implemented systems and procedures is equally, if not more important from a human factors standpoint. This highlights an opportunity to conduct exploratory research for operations - integrating human factors into day-to-day AT and TO activities at the facility level.

Involving and embedding human factors personnel at the facility level will:

- ◆ **Promote** proactive hazard identification
- ◆ **Improve** human-system performance safety
- ◆ **Engage** operational personnel in the AMS process

Conducting research for operations will improve services provided to the flying public, improve workplace conditions and culture, and assist the FAA in targeting areas for improvement proactively rather than reactively. Operational personnel with the support of human factors can assist in the identification of facility specific training requirements, consistent safety event reporting data, and root cause analyses to identify event causal factors. Information feedback at the facility level is critical to improving human performance and safety and supporting the FAA’s mission.



Human Centered Design

Strategic Objective 2

Implement human centered design concepts to achieve operational human performance objectives, reduce the likelihood of human error, and increase the availability of AT systems

“A major challenge is integrating human factors” with future “technology and procedures to ensure safety” (FAA, 2012b). To address this challenge, the ATC / TO Human Factors Team will champion the incorporation of human centered design into the earliest stages of AT idea, product, and system design to increase product usability. Human centered design is a multidisciplinary concept that improves the ability for users (humans) to effectively interact with technology and procedures to achieve human-system performance. Neglecting its incorporation will decrease human performance, increase the probability of human error, and impose unjustifiable risk to a program.

Over the years the FAA has made progressive updates to NAS systems. During these updates, numerous human factors challenges have emerged. Minimal guidance regarding the definition of supporting human roles and responsibilities, interface development, or the incorporation of emerging technologies in FAA documentation has led to human centered design shortfalls. As a result, standardization or uniformity across system interfaces is minimal. Benefits to standardization across systems may reduce training costs, improve workforce flexibility, improve human performance, and reduce system maintenance costs.

The Team will work with internal ATC and TO directorates to identify and mitigate system design shortfalls. As the ATO updates current systems and / or implements future systems, the Team is committed to ensuring that the human centered design concept is an embedded component of these updates. The Team will execute the following strategy to achieve this objective.

Strategy 2.1

Develop an integrated Air Traffic Management (ATM) philosophy for service-oriented workstations

Service-oriented workstations are currently defined via the AT services provided by ATCS to NAS consumers in one of the three air traffic domains: Tower, Terminal, and En Route. Services provided are constrained to the limitations of facility-specific and domain-specific hardware

and software, airspace configuration, and the inter-operability of AT systems with adjacent facilities.

The two radar environments, Terminal and En Route, have similar functions and capabilities but operate on different automation platforms that are being independently modernized. Research opportunities exist to develop an integrated ATM philosophy to address the application of successful, common human performance design elements from one domain to another to optimize human performance in future hardware and software releases.

Research philosophy products are multi-faceted. In this specific case, the philosophy is intended to integrate the human centered design and HSI concepts into AT system design. This will improve human performance and assist in risk reduction. The philosophy will assist operational personnel to achieve system level human performance objectives and system developers to integrate independent automation tools.

Upon completion of an integrated system design philosophy, there are long term opportunities to influence domain integration. Development of an integrated ATM philosophy for radar operations to optimize traffic flow will assist the FAA in achieving increased efficiency and system capacity in complex high volume airspace. An integrated ATM philosophy would ease the transition of domain integration and ensure that human performance is improved, rather than compromised, as the roles of air traffic service providers change to more efficiently meet user demand.

The ATC / TO Human Factors Team will:

- ◆ **Identify** requirements to support the development of an integrated ATM philosophy
- ◆ **Champion** the implementation of an integrated ATM philosophy to improve operational human performance
- ◆ **Evaluate** post-implementation effectiveness of an integrated ATM philosophy to document lessons learned for use by other programs

Strategy 2.2

Develop human factors system standards and guidelines to improve human-system performance

NAS service providers and maintainers are responsible for interacting with, operating, and maintaining a wide variety of systems that lack interface standardization and uniformity. As a result, there are inconsistencies across systems within and across AT facilities.

As incremental NAS improvements were made, standardization across those incremental improvements was minimal. As a result, the likelihood of human error increased presenting the opportunity for unintended AT system outages and human performance inefficiencies. Conducting research and development of products to address this challenge will create standardization across updated and future NAS systems. Operational benefits to this include increased NAS service provider and maintainer productivity, time and training efficiencies, increased system usability, monetary efficiencies, and decreased likelihood of human error.

Research opportunities to achieve this strategy include:

- ◆ Development of human factors system standards to improve system acquisitions and fielded system updates
- ◆ Development of human factors guidelines to support system standards and to ensure uniformity across NAS systems
- ◆ Development of publication standards to improve documentation and reduce the likelihood of human error
- ◆ Actively working with the ATO throughout the AMS process to develop, support implementation, and assess the success of new tools and job aids to increase human performance



Human Systems Integration

Strategic Objective 3

Lead the development and incorporation of the human systems integration (HSI) concept into an automated, future NAS

Human systems integration (HSI) is a comprehensive research concept utilized by the ATC / TO Human Factors Team. It serves as a method for mapping research needs and developmental concepts to four highly specific ATC / TO Human Factors research domains. Each of the four domains builds off of the human centered design concept and supports the identification of inter-related research needs to yield higher quality products for operations. Specific to the ATC / TO Human Factors Team, the HSI domains are: Human Factors, Safety, Training, and Personnel Selection. The ATC / TO Human Factors Team will closely collaborate and coordinate with internal and external organizations in planning, execution, and utilization of research.

As the FAA moves forward to achieve Agency level goals, human factors research is needed to support future NAS developments. Major changes to the ATC / TO workforce and work environment will have HSI impacts. To ensure a safe, successful transition to an automated NAS, the HSI concept will be utilized to identify human factors research needs for operations. The HSI concept also serves as a coordination tool between developmental concepts, active research requirements, planned research requirements, and FAA programs.

To achieve the full human factors benefits of the of the HSI concept, harmonization and active interaction among the HSI domains is required. The intent is for the product of one HSI domain to influence research needs and outputs in another HSI domain. This will promote the development of complete human factors solutions rather than isolated products. In taking this approach, the ATC / TO Human Factors Team will deliver comprehensive human factors solutions.

Strategy 3.1

Integrate applied human factors into the development of a human centered automation philosophy

“We are moving from a cognitive based aviation control system to a system with automated support for decisions, which will require a collaborative work environment” (FAA, 2012b).

Future AT system design will significantly increase levels of automation and ATCS use of decision support tools to complete job-related tasks. Automation will be instrumental in increasing safety and capacity only if it can be effectively utilized by the operator.

When a new AT system or capability is in its infancy, the FAA will develop a Concept of Operations (ConOps) which will then drive the development of system and functional requirements. Any shortfalls in requirement development can lead to safety critical impacts for system users and NAS consumers if not mitigated prior to implementation. Incorporation of both the human centered design and HSI concepts is imperative during this stage of system design.

To ensure the incorporation of both concepts, the ATC / TO Human Factors Team will lead and champion the development of a human centered automation philosophy. The philosophy will be geared towards the operation of domain specific AT systems used by ATCS. This perspective will promote human centered system design and act as a barrier for designer errors leading to unintended operator errors. Additionally the philosophy will provide standardized methods of testing automation for human performance shortfalls to mitigate them prior to implementation.

Strategy 3.2

Further develop the Air-Ground Integration concept to improve operational Controller-Pilot situational awareness and decision making abilities

In support of the FAA's effort to update the AT system, the Air-Ground Integration (AGI) concept "focuses on the interactions of people, technology, and procedures across all domains of the NAS" (Volpe, 2011). Examining the roles, responsibilities, and interactions specifically between pilots and ATCS is vital to integrating HSI into future system and procedural design.

One of the primary AGI research goals is to address potential changes in the responsibility between ATCS and pilots. The intent is to use increased levels of automation with various decision support tools to create a collaborative environment that improves air traffic safety, capacity, and efficiency. This goal could be achieved through the issuance of strategic AT



clearances versus segmented and sometimes reactive clearances. This may inherently change the way pilots and controllers interact and how they perform operational tasks.

During the transition to an automated NAS, there are numerous aspects of the AGI concept that may affect human performance. Infusing the HSI concept into system and procedure design will ensure that human performance, situational awareness, and NAS actor decision making abilities move in a positive direction. The ATC / TO Human Factors Team will support the AGI concept by ensuring that the human element of a future NAS is properly integrated into all the developmental and acquisition programs where possible. This will be supported by the ATC / TO Human Factors Team by:

- ◆ Developing AGI scenarios to identify human performance barriers affecting controller situational awareness and decision making abilities
- ◆ Conducting human-in-the-loop (HITL) simulations to identify and mitigate human factors issues associated with human performance to support the pre-implementation of new technology and procedures
- ◆ Supporting the conduct of AGI procedure and technology benefits assessments from a human factors perspective
- ◆ Monitoring and evaluating post-implementation human-system performance with new technologies and procedures supporting the AGI concept

Strategy 3.3

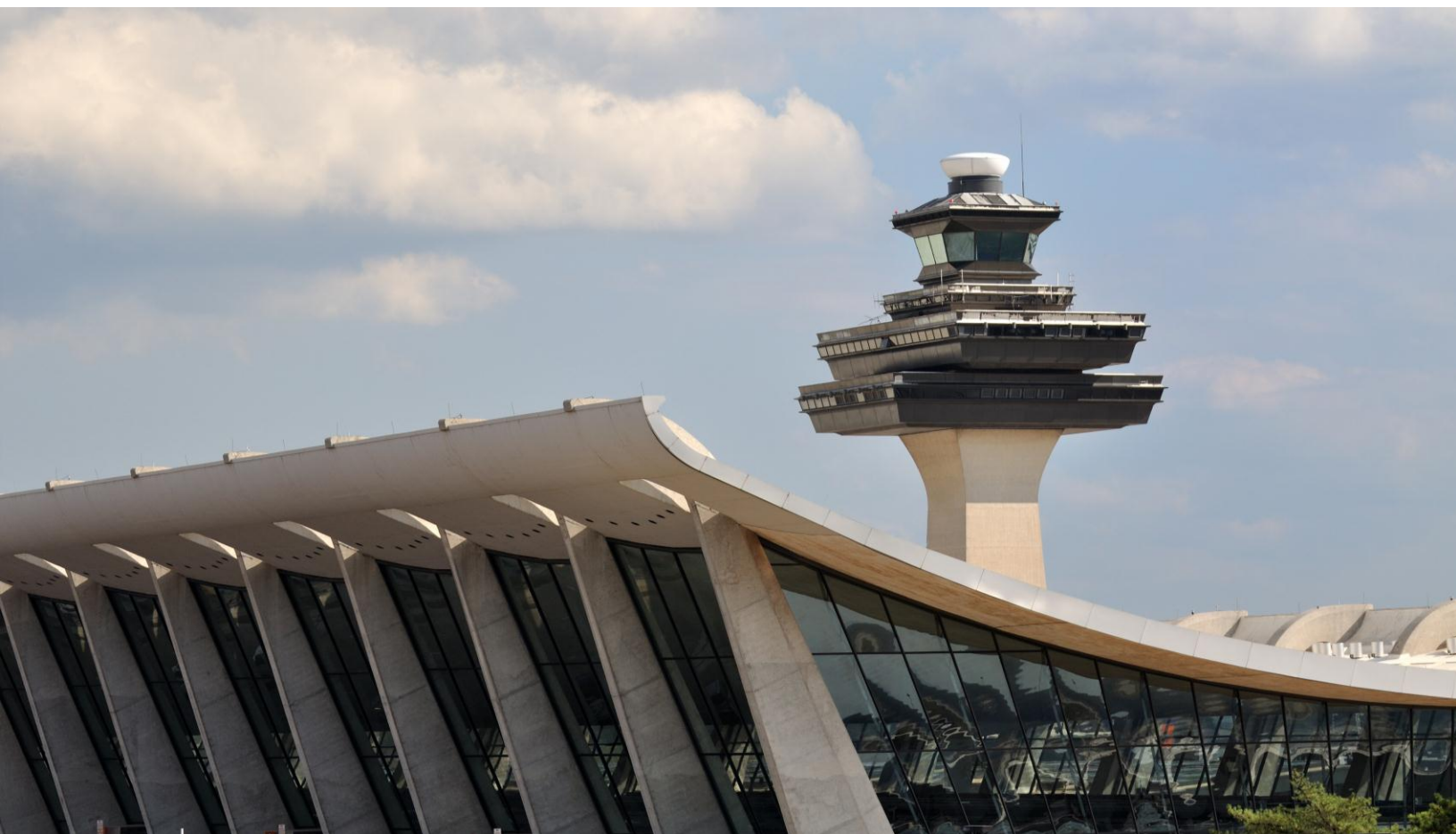
Improve human factors practices and principles to procure, design, develop, and test future FAA concepts, systems, facilities, and equipment to realize end-to-end human performance benefits

One of the Destination 2025 strategies to achieve the **Next Level of Safety** is to “strengthen and improve technology, infrastructure, training, procedures, evaluation, analysis, testing, and certification to reduce the risk of accidents from all causes in all phases of operation”. The ATC / TO Human Factors Team has the opportunity to address this challenge through early engagement with FAA programs throughout the product development lifecycle and AMS processes. Involving human factors in the procurement, design, and testing of future FAA concepts, systems, facilities, and equipment has proven to reduce programmatic costs, improve safety and efficiency.

Traditionally the greatest opportunity for risk realization with the lowest safety consequences occurs during pre-implementation activities. Conversely, the lowest likelihood of risk realization with the highest safety consequences occurs when a product is implemented into operations. To minimize program costs and schedule delays as a result of re-engineering future products, human factors must be engaged in the earliest stages of product development. This will ensure that future products are engineered with the end-user in mind. Leveraging the HSI concept, product usability, training, personnel selection criteria, and safety need to be thoroughly evaluated.

The Human Factors ATC / TO Team will address this by:

- ◆ Revising Human Factors Standards to include guidelines and standards for emerging technologies and computer human interface (CHI) design
- ◆ Updating the Human Factors Acquisition Tool so the FAA Program Management Office (PMO) has the most up-to-date human factors resources and inputs available throughout the AMS process
- ◆ Recommending human factors practices and principles to be further included in future SMS manual updates



Selection and Training Process Improvement

Strategic Objective 4

Strengthen the FAA's personnel selection and training process to improve the hiring and maintaining of a qualified, diverse, workforce of the future

The FAA is **Delivering Aviation Access through Innovation** by “ensuring that airport and airspace capacity are more efficient, predictable, cost-effective, and matched to public needs” (FAA, 2012b). Achieving this goal is dependent on the FAA having “the right people with the right skills in the right positions at the right time” (FAA, 2012b). As the FAA transitions to a future NAS, an adequate number of controllers must be available to staff workstation positions and handle variance in traffic levels. At the facility level, the FAA needs to ensure that expected staffing requirements are met two to three years in advance to allow sufficient training time for new hires (FAA, 2011).

In response to these needs, the FAA has made significant progress to date. For example, in 2002 the FAA implemented “the Air Traffic Selection and Training (AT-SAT) test battery in place of a two-stage selection process in which air traffic applicants completed an Office of Personnel Management (OPM) test battery and a nine-week screening program at the FAA Academy” (King, Manning, & Dreschler, 2007). The AT-SAT test battery was developed with oversight of the FAA Civil Aerospace Medical Institute (CAMI) and was concurrently validated using incumbent En Route ATCS.

Building on past achievements, there is a reinforced need for the FAA to continue to strengthen its personnel selection and training processes. Benefits to refined selection, such as decreased costs, attrition rates, and increased training efficiencies, can be further realized. To advance research and development of products to improve personnel selection, the ATC / TO Human Factors Team will undertake the following strategies so that the FAA employs a qualified workforce that meets the needs of the NAS.



Strategy 4.1

Improve existing AT selection tests to reduce Agency costs of hiring ATCS through refined selection

The AT-SAT test battery was implemented by the FAA as an “aptitude test and not a test of air traffic control knowledge”. “The goal of AT-SAT is to gauge the likelihood of success in air traffic control training, and more importantly...on-the-job” (FAA, 2008a).

General public and Air Traffic Collegiate Training Initiative (AT-CTI) graduate applicants are required to take the AT-SAT test battery as a part of the pre-employment process. As the FAA continues to select the workforce of the future, AT-SAT improvements are needed to increase its reliability and validity so it continues to meet the needs of the FAA. To satisfy these needs, the ATC / TO Human Factors Team will:

- ◆ Determine the degree to which the AT-SAT test battery predicts controller performance
- ◆ Execute validation studies to ensure that the AT-SAT test battery continues to perform as intended
- ◆ Utilize data from validation studies to develop a legally defensible case to continue the use of the AT-SAT test battery as a part of the pre-employment process
- ◆ Develop AT-SAT test battery improvements to enhance existing test measures
- ◆ Continue to actively work with the ATO, Administration of Talent Management, Technical Workforce Services, and the Office of Human Resources Management to identify future research requirements that result in AT-SAT improvements as a result of scientifically based recommendations from the ATC / TO Human Factors Team.

Strategy 4.2

Improve applicant placement by facility type to increase training efficiencies and decrease developmental attrition rates

Despite the recent 23% decline in system-wide traffic since the peak in 2000, air traffic forecasts indicate a gradual increase in volume over the next ten years (FAA, 2011). Proactively maintaining a workforce that stays ahead of anticipated traffic levels and system attrition is required for the FAA to ensure that air traffic system capacity is able to meet user demand. Therefore it is critical that FAA correctly places new controllers in facility types and levels that match their skills.

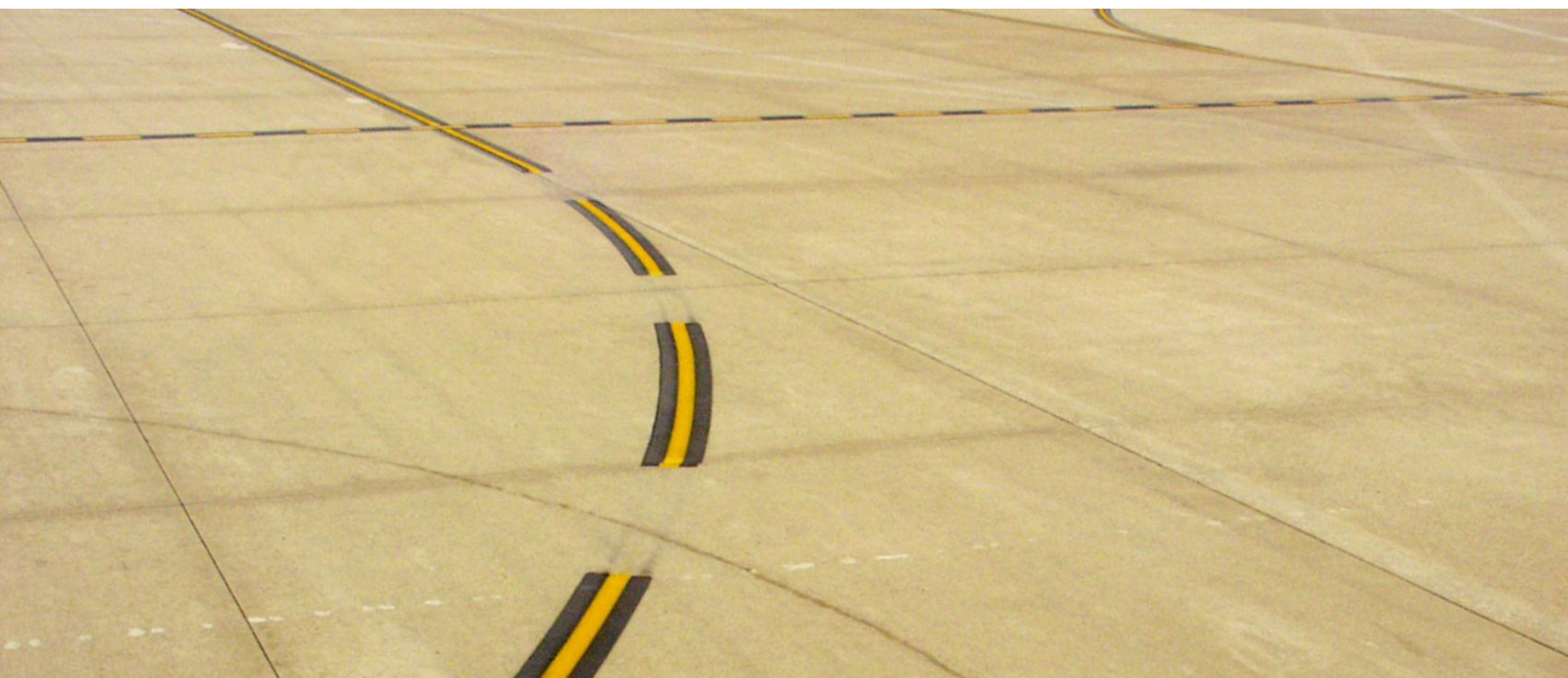
The predicted attrition for ATC applicants at the FAA Academy and developmentals training at facilities from 2011 through 2020 is 2,082 controllers combined (FAA, 2011). Incremental

improvements to the AT-SAT test battery assist in controlling the attrition rate however, the ATC / TO Human Factors Team is committed to assisting in the further reduction of this number.

In the current system, the FAA places AT applicants where and when an operational vacancy exists. To assist in the reduction of projected attrition, the Team has engaged in research that evaluates the effectiveness of the AT-SAT test battery for placement of applicants by option and facility level. This research is supported by the United States Department of Transportation (DOT) Office of Inspector General (OIG), FAA ATO Terminal Planning, Terminal Mission Support, and Human Resources. Extensive cost, training, and time resource efficiencies will be achieved through the completion of this research.

To further improve applicant placement, the Team will engage in broader activities to assist in refining personnel selection processes by:

- ◆ Determining which applicants should be required to take the AT-SAT test battery as a part of the pre-employment process
- ◆ Improving the validity and reliability of the performance assessment conducted at the FAA Academy



Strategy 4.3

Expand technical and personal development training to improve skills and abilities of the workforce to perform job functions and maintain the safety of the NAS

“One of the primary goals of the FAA’s technical training and development programs is to ensure that our Air Traffic Controllers have all the necessary skills and abilities to perform their job effectively and maintain the safety of the NAS” (FAA, 2011). To achieve the **Next Level of Safety**, ATCS and TO personnel must engage in training that addresses the human factors and safety aspects of the human-systems-integration (HSI) concept. In doing this, it will promote a conducive, safer work environment and will minimize human performance and safety risks to the NAS. The Team will engage in research that:

- ◆ Develops platforms to successfully deliver training to operational personnel so user-acceptance is maximized
- ◆ Develops an evaluation method to improve instructional system design quality for ATC training
- ◆ Leverages collaboration with international FAA partners to further develop and effectively deploy existing or new training materials to AT operations
- ◆ Develops a human factors process to conduct post-training implementation assessments of training effectiveness and target community acceptance

Strategy 4.4

Improve Technical Operations workforce selection, training, and workforce maintenance

As the FAA transitions to a future NAS, there will be a period of deployment and integration of new technologies with existing infrastructure. This will create a complex operational environment in which legacy systems and more current technologies are maintained in parallel by TO.

As the TO domain evolves, it is vital that the FAA understands the mixed knowledge, skills, abilities, and other characteristics required of the TO workforce. This again will ensure that the FAA has “the right people with the right skills in the right positions at the right time” (FAA, 2012b).

The ATC / TO Human Factors Team will undertake research that:

- ◆ Defines the required job skills and abilities to develop training requirements for TO
- ◆ Identifies TO selection criteria to improve the selection process
- ◆ Supports the FAA's development of a "Technical Operations Workforce Strategy" to respond to the October 2010 Government Accountability Office (GAO) Report recommendation(s)

Strategy 4.5

Proactively assess AT and TO job-tasks to identify emerging KSAOs during the transition to an automated NAS for future selection process improvement

The ATC / TO Human Factors Team is responsible for identifying "New Service Needs" of the AT and TO Organizations. As the FAA transitions to a future NAS, the roles and responsibilities of ATCS and TO personnel may change. Proactively identifying required KSAOs far enough in advance of the deployment of future technologies and procedures is critical. This will allow the FAA to revise future selection processes to ensure that "the right people with the right skills" are "in the right positions at the right time" (FAA, 2012b).

During the transition to a future NAS, there will be a period of deployment and integration of new technologies with existing infrastructure. This will create a complex operational environment in which legacy systems and more current technologies are utilized in parallel by NAS service providers and maintainers.

To meet these needs the ATC / TO Human Factors Team will undertake research that supports:

- ◆ Definition of future ATC and TO KSAOs to update and validate future selection processes
- ◆ Definition of required job skills and abilities to develop training requirements for ATC and TO



Increase Human Performance and Safety

Strategic Objective 5

Maintain a high level of human performance and safety within the current and future NAS as new technologies and operations are introduced to the AT system

The ATC / TO Human Factors Team is committed to ensuring that human performance and safety is enhanced as new technologies, procedures, or policies are introduced to the current and future AT system. This will be accomplished through the prioritization of research that improves safety event data collection, development of new analytical methods to enable a better understanding of safety event causal factors, derivation of human factors interventions to prevent undesired events, and the proactive detection of emerging human error hazards. Work conducted by the ATC / TO Human Factors Team will work towards achieving the **Next Level of Safety** via human performance research.

Research activities within this objective scope support the achievement of the following Destination 2025 (FAA, 2012b), **Next Level of Safety** goal and performance metrics from an ATC standpoint:

- ◆ “Reduce commercial air carrier fatalities per 100 million persons on board by 24% over a 9-year period (2010-2018). No more than 6.2 in 2018.”
- ◆ “Maintain the rate of serious runway incursions at or below 20 per 1,000 events.”
- ◆ “Reduces risks in flight by limiting the rate of the most serious losses of standard separation to 20 or fewer for every thousand (.02) losses of standard separation within the NAS.”

The ATC / TO Human Factors Team will execute the successive strategies to maintain a high level of human performance and safety and move towards the achievement of FAA safety objectives.

Strategy 5.1

Improve NAS actor performance so the probability of human error within the Air Traffic system is reduced

The Team is committed to proactively improving human performance and safety through the identification of human performance risks and reducing the likelihood of human error in system or procedure design prior to implementation. As new technologies are deployed to AT facilities, the roles and responsibilities of the various NAS actors may inherently change. Research is needed to ensure improvement in individual and team human performance as these changes are executed.

Early engagement with programs executing the FAA AMS process will support the end-to-end realization of human factors benefits during the pre and post-implementation phases of a program or project. Measuring the effectiveness of interventions and human performance is pivotal to achieve this strategy. Research activities within this scope include:

- ◆ Development of a human performance baseline to assess the effectiveness of targeted mitigations against identified human performance challenges and / or error types
- ◆ Development of methods to prevent degradation of skill retention as ATC and TO transition to an automated NAS
- ◆ Development of an ATC best practices with inputs from high performing controllers to define training requirements



Strategy 5.2

Support the use of Safety Management Systems (SMS) to proactively identify, manage, and mitigate human factors risk(s) to the NAS and identify contributing AT incident and accident causal factors to promote the future optimization of ATC and TO performance

The ATO implemented the Safety Management System (SMS) with the “goal of providing a safer NAS” (FAA, 2008b). The SMS is an integrated collection of processes, procedures, policies, and programs used to assess, define, and manage the safety risk in the provision of ATC.

Since its implementation 2010, the FAA’s safety culture has moved in a positive direction. SMS has provided the FAA with a “common framework to assess safety risks associated with changes to the NAS”, participation of intra-agency stakeholders in solving the safety challenges of an increasingly complex NAS, reduction in the number of isolated safety decisions, saving both time and resources, and fewer incidents as a result of multiple service units working together (FAA, 2008b). Despite these recent accomplishments, the SMS concept, process, and products will continue to evolve so the needs of the NAS are met.

The Team has the opportunity to assist the FAA in closing human performance gaps and the ability to establish barriers to remove unacceptable human performance risk from the aviation system. This can be accomplished by:

- ◆ Leading the development of human performance hazard assessments to mitigate risks with future Air Traffic and Technical Operations procedures, technologies, and policies
- ◆ Championing the integration of human performance hazard identification into the SMS process
- ◆ Support the consistent integration of SMS updates across the FAA
- ◆ Collaborating with FAA programs to incorporate and achieve the safety benefits of human-centered system design

Identifying and understanding the underlying causal factors of Air Traffic related accidents and incidents are vital to achieving the FAA’s **Next Level of Safety**. Leveraging lessons learned and responding to current operational needs will assist in the prevention of future safety events that can lead to undesirable outcomes.

In 2010, the ATO successfully implemented the voluntary Air Traffic Safety Action Program (ATSAP). In 2012, the Technical Operations Safety Action Program (T-SAP), modeled after ATSAP, was implemented by TO as well. Both programs support the SMS and serve as a non-punitive, voluntary method to report safety events so future operational safety can be improved.

The Team has several “research for operations” opportunities to proactively identify human performance shortfalls and trends within the AT and TO domains. Future AT and TO research will promote:

- ◆ Consistent levels of detail in safety event narratives to increase the usability of data
- ◆ Development of additional human factors methods to determine the root cause of human performance and safety events
- ◆ Analysis of safety event reports to develop targeted mitigations to improve human-system performance

Strategy 5.3

Improve AT system availability through the reduction of unplanned AT system outages as a result of human error

As new capabilities and systems are deployed, levels of automation will increase and tolerance for system outages will decrease. It is critical that air navigation automation, infrastructure, and associated systems are reliable and efficiently maintained by TO personnel. Human performance can directly impact AT system performance if unintended outages occur during system maintenance. Identification of human performance challenges and mitigations is critical for system capacity to consistently match user demand.

The Team will prioritize research that:

- ◆ Identifies and develops countermeasures to reduce human error during the maintenance of Air Traffic systems to decrease the rate of unscheduled Air Traffic system outages
- ◆ Determines the effectiveness of human error countermeasures, gaps, and ways to further improve human performance in Technical Operations
- ◆ Develops human performance measures and metrics to assess long-term maintenance program performance
- ◆ Develop information requirements for TO personnel during the certification of maintenance conducted on NAS systems by vendors other than the FAA



List of Acronyms

Acronym	Definition
AGI	Air-Ground Integration
AMS	Acquisition Management System
AT	Air Traffic
ATC	Air Traffic Control
ATCS	Air Traffic Control Specialist
AT-CTI	Air Traffic Collegiate Training Initiative
ATM	Air Traffic Management
ATO	Air Traffic Organization
ATSAP	Air Traffic Safety Action Program
AT-SAT	Air Traffic Selection and Training
CAMI	Civil Aerospace Medical Institute
CHI	Computer-Human-Interface
ConOps	Concept of Operations
DOT	Department of Transportation
FAA	Federal Aviation Administration
GAO	Government Accountability Office
HF	Human Factors
HITL	Human-in-the-Loop
HSI	Human Systems Integration
NARP	National Aviation Research Plan
NAS	National Airspace System
OIG	Office of Inspector General
OPM	Office of Personnel Management
PMO	Program Management Office
TO	Technical Operations
REDAC	Research Engineering and Development Advisory Committee
T-SAP	Technical Operations Safety Action Program
SMS	Safety Management System

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